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The most important thing, potentially, for meteorology that happened during the Baltimore meetings, was the reading by Major Squier, of his valuable paper on aeronautics, and the consequent decision, on the part of Section D, to make aeronautics and aerophysics prominent features at the next and subsequent meetings of the association.

Aeronautics is sure to stimulate, as never before, the study of the directions, the turbulence, and the other properties of wind currents, and at the same time to furnish the best means for solving these and kindred problems; so that it is not too much to say that a new meteorological era, new in the extent of its usefulness, and new in the rapidity of its advance, is at hand. And he who in any way contributes to this advance will have done something of the greatest good it is given man to do; for to that extent, be it much or be it little, because of his labors and of his discoveries, the world will be wiser and the energies of men more productive.

A PROPOSED NEW FORMULA FOR EVAPORATION.

By C. F. Marvin, Professor of Meteorology. Dated March 21, 1909.

The attention of the writer has been called to the perplexi-

ties that have arisen in the discussion of evaporation observations at Reno, Indio, and elsewhere, whereby it seems that some factor influencing evaporation is missing, as it were. The whole subject is very fully discussd by Professor Bigelow¹ in a series of papers in the MONTHLY WEATHER REVIEW.

The observations seem to indicate in certain cases that notably different amounts of evaporation are observed under seemingly the same meteorological conditions, or, that the same amounts of evaporation are found when the observed meteorological conditions are notably different. The writer has not had an opportunity to closely scrutinize the original data, but, with a view of bringing in a different and perhaps a new and independent line of thought on this problem, I have endeavored to take up *de novo* the general question of the evaporation equation. The results of this study are given in what follows.

Let us imagine we have a free surface of water, perfectly smooth, with dry air over it.

The kinetic theory of vapor tells us that molecules of water vapor are being continually shot out thru the superficial film of the water surface into the air above and beyond. Let us suppose, to start with, that these molecules are able to escape to an indefinite distance from the water surface so that they can not return. The water thus lost is the true or absolute evaporation that can take place under the given conditions. Now, we believe that there are only two conditions that can influence the amount of water thus evaporated. We know that if the water is warm the molecules are shot out faster than if it is cold. We also know that the greater the pressure or density of the air or gas over the water the slower will be the evaporation. Remembering that we have assumed that all the molecules shot out escape from the water entirely, we do not see that any other conditions can influence the absolute rate of evaporation. We recognize, of course, the effects of impurities in the water, etc.

If T_s is the water surface temperature, and B is the atmospheric pressure, then the conclusion we have just stated may be represented, mathematically, by the expression:

Absolute evaporation, per unit of time, varies as $\frac{T_s}{B}$.

Our assumed conditions, however, do not represent any ordinary state in nature. The molecules shot out from the water can not all escape. They collide with each other and with the air particles so that their complete escape is quite impossible. In fact, much of the moisture evaporated becomes entangled in the thin layer of mixt air and vapor near the water, and many of the vapor particles in this layer shoot back into the water; consequently, the *apparent* evaporation, which is the only thing we can measure, and which now concerns us, is the difference between the vapor shot out from the water and that which returns from the overlying gaseous sheet.

The object now in hand is to formulate an equation that shall express as nearly as may be the relation between the surrounding conditions and this apparent evaporation. As we have already seen, the rate of evaporation will be greater and greater the higher the temperature of the water. It will also be greater the higher the temperature of the sheet of air and vapor over the water, because the higher this temperature the greater is the capacity of this space to receive and disseminate moisture. On the other hand the rate of evaporation will be less the greater the quantity of vapor already present in the overlying gaseous sheet. It will also be less the greater the gross barometric pressure. Finally, the more the wind blows the faster will dry air replace the moist and thus make faster evaporation possible.

¹ Bigelow, F. H. Monthly Weather Review, July, 1907, p. 311; February, 1908, p. 24; Summary, 1908, p. 437.

Now, these several relations can be represented mathematically by two essentially different expressions; namely, by appropriate ratios, or by the choice of suitable differences. For example, the fact that the rate of evaporation increases with the increase of water and air temperature and wind, but decreases with increase of barometric pressure and of the temperature of the dew-point is expressed by writing either:

$$(1) \quad \frac{dE}{dt} \text{ varies as } \frac{T_s \times T_a \times V}{T_d \times B},$$

or

$$(2) \quad \frac{dE}{dt} \text{ varies as } (T_s + T_a - T_d) \frac{V}{B},$$

or by some modification of these mathematical forms.

The first expression utilizes simply products and ratios; whereas, in the second these mathematical forms are combined with sums and differences. If we strike out of (1) the terms depending on barometer and air temperature, namely, $\frac{T_a}{B}$ and supply the terms $\frac{de}{ds}$ we get

$$(3) \quad \frac{dE}{dt} \text{ varies as } \frac{T_s}{T_d} \cdot \frac{de}{ds} V.$$

This is essentially the Bigelow equation.

Similarly, by striking out the same terms T_a and B from (2), we get:

$$(4) \quad \frac{dE}{dt} \text{ varies as } (T_s - T_d) V,$$

which is essentially the Dalton equation.

Both these equations disregard the barometer term, and omit the influence that the air temperature has on the evaporation.

Professor Bigelow has been led to the adoption of his equation by a very different line of thought from the one here followed and has extensively employed the ratio expression in the analysis of observations made at Reno, Nev., and Indio, Cal. Further on I shall discuss, with some fullness, the defects of both the above equations. At present I desire to convert the second form of expression given into an evaporation formula that will be more convenient for our use.

For very good reasons which need not be given at this time, it is inconvenient to use *temperatures* directly in the evaporation equation, and I therefore propose to substitute at once the more convenient and closely related, and equally important, saturation vapor pressures, namely:

e_s =saturation vapor pressures corresponding to T_s =water temperature.

e_a =saturation vapor pressures corresponding to T_a =air temperature.

e_d =saturation vapor pressures corresponding to T_d =dew-point temperature.

On this basis the expression (2) becomes:

$$(5) \quad \frac{dE}{dt} \text{ varies as } (e_s + e_a - e_d) \frac{V}{B}.$$

No equation for evaporation can be accepted that does not give us zero evaporation under those conditions in which physics teaches us that the evaporation must be zero.

The fundamental conditions under which the apparent evaporation will be zero are simply these. The temperature of the air over the water must be the same as that of the water and the space must be saturated with vapor. We may state this in other words by saying that the state of equilibrium in which the apparent evaporation is zero is established only when the temperature of the water, the temperature of the air, and the temperature of the dew-point, all come to a perfect identity. If the wind blows and brings in new air, this must be saturated and at the same temperature, otherwise either evaporation or condensation will take place.

The only thing that it is necessary to do to make our ex-

pression (5) satisfy this fundamental requirement is to place the coefficient 2 before the factor e_d . In fact, we may write the equation at once in the following form:

$$(6) \quad \frac{dE}{dt} = \frac{C}{B} (e_s + e_a - 2e_d) f(e) f(v).$$

The new and important feature presented in this equation is the expression or term which we write:

$$(7) \quad e_s + e_a - 2e_d = p.$$

This term has all the qualities of a thermodynamic difference of potential for evaporation, and I think we may call it the evaporation potential.² As its values rise or fall, or become zero, positive or negative, so the evaporation is great or little, zero, or positive or negative.

This is clearly brought out in the following examination of the expression:

Suppose the air and water are both warm and the air absolutely dry, e_a and e_s are then both large, and $e_d=0$; whence the potential will have a large value, and thus satisfy the physical demands which call for a large evaporation under the conditions assumed. If we imagine the moisture to accumulate in the air, then e_d becomes larger and larger, and the value of the potential term is correspondingly lowered, indicating a less evaporation which we know must be the case. When the air becomes saturated, $e_d=e_a$ and the potential becomes $p=(e_s-e_a)$. This expression acquires a very interesting significance with the different values of e_s and e_a . For example, suppose that even tho the air be saturated the water is warmer than the air, a condition that frequently occurs in nature. The potential in this case is still finite and positive, which means that vapor will still come off from the water. In fact, the condition is one that explains and accounts for the low layer of fog found over water surfaces on some occasions. If now, we suppose the water is colder than the air, then e_s-e_a becomes negative and the equation gives us a negative evaporation. That is, moisture will condense from the damp air upon the cold water surface. Finally, remembering that we are dealing with saturated air, our whole expression reduces to zero when we assume that $e_s=e_a$. Thus we find that the potential term in this form enables the evaporation equation to meet all the physical demands put upon it, in an entirely comprehensive manner.

The remaining terms of the equation must, of course, be more fully formulated and ultimately evaluated, which is not possible until we have plenty of good observations over a wide range of conditions in which each factor has been accurately measured.

We shall probably have very little difficulty with the barometer term $\frac{1}{B}$ in equation (6). Doubtless it can be written in the

form $\frac{B_o}{B}$, where B is the actual and B_o some standard pressure,

e. g. 760 millimeters. At any one elevation above sea-level, the ratio $\frac{B_o}{B}$ does not ordinarily differ more than one or two per cent

from a mean value. It will, therefore, ordinarily be sufficiently exact to combine this mean pressure term with the general constant of the equation.

²The word "potential" is often used, as in the present case, with slight respect to its real technical meaning. Strictly, in the present connection, potential has reference to the state or condition, or relation, of two or more material things, or arrangements, by virtue of which work will be done if the relations are permitted to change spontaneously; or work must be done upon the arrangement in order to change the existing relations otherwise. We have no means of knowing the absolute potential, and, in the present case, all we are concerned with is the difference in potential, by virtue of which the evaporation will be large or small, positive or negative, or zero, according as the difference of potential is large, or small, positive or negative, or zero.

The term $f(e)$ is introduced because without it the equation would affirm that the evaporation and the thermal difference of potential would vary over an indefinite range in a strictly linear relation. This, I think, is quite unlikely. Therefore, some additional function of the thermal factors influencing the rate of evaporation is necessary, or, some exponential relations between these variables must be employed to provide for the probable deviation from a straight-line relation. The expression $f(e)$ is inserted to meet this demand, and will be retained until observations enable us to evaluate it or demonstrate that it is unnecessary.

The wind term $f(v)$ is one the importance of which the writer believes must not be underestimated or subordinated. Dalton assumed that the evaporation increased simply directly as the wind velocity. Professor Bigelow has adopted this view, and, for his first approximation, uses the term $(1+.0175V)$ to represent his Reno observations. In other words the evaporation increases with the wind at the rate of 1.75 per cent per kilometer increase in the hourly velocity of the wind. I believe this simple relation fails to satisfactorily express the real action that takes place. Our knowledge of the effect of wind on a wet-bulb thermometer ought to aid us in forming correct ideas in these matters. Experiment shows that a wet-bulb thermometer in quiescent air cools down by evaporation to a certain definite temperature. If now this air is set in gentle motion a considerable further cooling takes place which is increased by increasing the ventilation, but the further cooling by still greater wind velocities is by no means directly proportional to the increase in wind. Shown graphically, the Bigelow wind effect may be represented by the straight line OB , fig. 1. I think that the real effect is more nearly represented by a curved line OM . It is fully recognized that the line OB is only tentative and rests on very scanty observational data, but I think we must not continue to be content with the simple linear form of the wind influence. I doubt very much if such a term will correctly represent the effect of very light winds, or strong winds on large water surfaces where wave action is strongly developed.

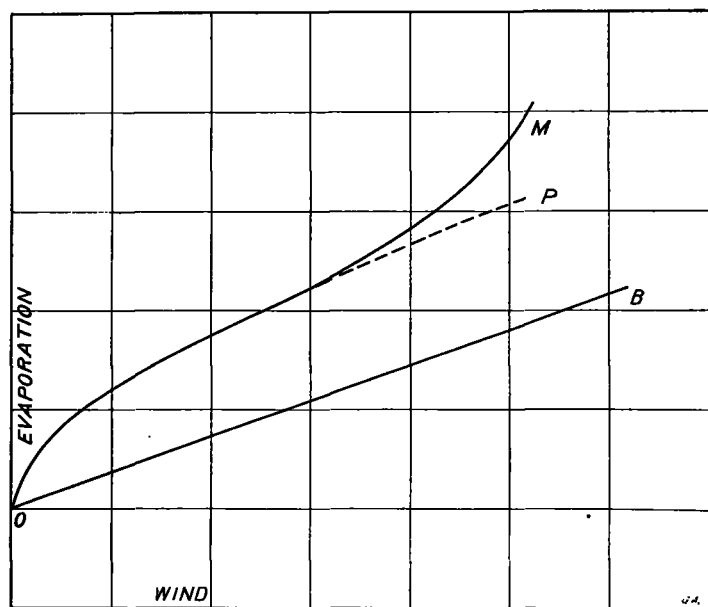


FIG. 1.—Diagrammatic presentation of the wind-effect in evaporation.

The double curvature of the line OM is intended to indicate the real effect we imagine the wind must have. When we observe the evaporation of water in pans, it seems probable the rate, as influenced by the wind can be represented by a line of single curvature. Probably a line of general parabolic character—3

ter will closely represent the wind effect. But we must not lose sight of the fact that the whole object in view is to formulate an equation that can be applied to open lakes and reservoirs subject to natural conditions. Now, the mass of water, even in a large pan, is so small and so sheltered by the rim that large waves and whitecaps are quite impossible even with very strong winds. On the other hand the wave effect is greatly developed in the open lake where whitecaps are easily formed, which with a number of other concomitant effects must all go to greatly increase the evaporation.

In the absence of observations the line OM is, of course, largely conjectural, but it seems to me a rational conception of the problem indicates that a line of double curvature like OM is required to fully represent the wind effect over large surfaces and large ranges of conditions.

A study of the wave effect has literally not been touched, as yet, and doubtless presents great difficulties. While observations are being confined to pans the line of single curvature like OP is doubtless quite sufficient. This can be written in the equation by the expression $(1+av^n)$, where n is 2 or some similar number.

The broad generalizations employed in the development of the new equation do not enable us to specify the exact mathematical form of the several factors controlling evaporation, but the method has this peculiar merit, that in following its guidance we are prevented from getting very far away from a strictly rational general result.

We must defer the further detailed development of the new equation until we have the observational data necessary for that purpose. In the meantime, it will be instructive to consider some of the defects in the other equations.

The Dalton equation has been used by a number of writers in the following form:

$$(8) \quad E = C(e_s - e_d)(1 + av).$$

By this equation the evaporation will be zero when $e_s - e_d = 0$, that is, when the water surface is at the temperature of the dew-point, which is obviously only true when the air is also at the same temperature. Dalton's equation just misses coming close to the truth by its failure to recognize the part the air temperature takes in controlling evaporation. We have already indicated the probable insufficiency in the wind factor $(1 + av)$.

The Bigelow equations.—The Bigelow equations, as we have already indicated, introduce variable factors in the form of ratios, and in this respect they are essentially different from the equations employed by others. Professor Bigelow arrived at his results thru a line of reasoning very different from any herein presented. It is desirable, therefore, to follow over his elaborate work and indicate some conclusions that admit of discussion. As his ideas are fully outlined in the several papers already cited, the reader must consult them for such details as are omitted here.

More than one form of equation has been employed by him from time to time, but, for the present, we may take the following form:

$$(9) \quad E = C \frac{e_s}{e_d} \frac{de}{ds} (1 + av).$$

The principal modifications in this formula that have been made from time to time have been in the ratio $\frac{e_s}{e_d}$, which is the

ratio obtained by dividing the vapor pressure corresponding to the temperature of the water surface by the vapor pressure for the dew-point of the free air. Instead of the latter, Professor Bigelow sometimes substitutes the vapor pressure 1 centimeter above the surface of the water.

We do not need to concern ourselves further than we already have with the wind term $(1 + av)$, but will give attention to the factors:

$$C \frac{e_s}{e_d} \frac{de}{ds}.$$

In this expression $\frac{de}{ds}$ is simply the *tabular difference* in the ordinary table of saturated vapor pressures for successive temperatures, and is used here to represent the rate of change of vapor pressure with temperature corresponding to the temperature of the water surface. Professor Bigelow transports this factor from an equation in thermodynamics due to Clayperon, and (by a demonstration which he gives in full at p. 438, Table 23, MONTHLY WEATHER REVIEW, Annual Summary, 1908), he is led to believe that the ratio $\frac{de}{ds}$ is equivalent to

the vapor density \times constant, and, as such, may be used in the evaporation equation on the ground that it is proportional to the mass of vapor that passes away from the water surface along the tubes of flow.

The Clayperon equation alluded to may be written:

$$(10) \quad \frac{de}{ds} = K \frac{r_2}{T} \frac{1}{(v_1 - v_2)}$$

in which K is a constant, r_2 the latent heat of evaporation of the vapor considered, T its absolute temperature, and v_1 and v_2 the volumes of the gas and of the liquid which forms the vapor by its complete evaporation.

This equation deals essentially with a definite *static* state of the vapor derived from a given volume of liquid, and has been used by Clausius, and more recently by Ekholm³, with striking success to formulate the relation between the saturation pressure and the temperature of water vapor. But the phenomenon of evaporation that we are now considering is essentially a dynamic process, not a static condition, and it has not yet been demonstrated that the Clayperon equation is applicable to evaporation data.

Aside from this fact, the ratio is subject to certain sharp limitations that confine its use to a narrow range of temperatures.

The demonstration that

$$(11) \quad \frac{de}{ds} = \frac{K}{v_1 - v_2} \frac{r_2}{T} = \text{density} \times \text{constant},$$

rests on the assumption that the ratio $\frac{r_2}{T} = \text{constant}$. This is nearly true only when we limit the application of the equation to a narrow range of temperature. The variation of $\frac{r_2}{T}$ is as great as 5 per cent in the range of temperatures from 10° to 30°C.

This amount of variation rather exceeds the limit of toleration that we should like to allow in a fundamental formula. Moreover, the range 10° to 30°C., is quite too narrow for many important problems. Thus, for instance, we want to be able to handle evaporation from snow at temperatures where the equation would be more than 10 per cent in error. If, therefore, the term is to be retained in a general equation, it will need to be accompanied by the ratio $\frac{r_2}{T}$.

The ratio $\frac{e_s}{e_d}$ or its alternative $\frac{e_s}{e_r}$, is employed by Professor Bigelow, as we understand him, on the basis that it measures, in some way, the vapor pressure *gradient* over or at the water surface. This vapor pressure gradient is one of the forces that causes the vapor to diffuse away from the water, so that the product $\frac{e_s}{e_d} \cdot \frac{de}{ds}$ is of the order of mass multiplied by

gradient, and is logically proportional to evaporation. But I think the term $\frac{e_s}{e_d}$ does not have the quality of a gradient at all.

In electricity, for example, the flow of current is proportional to *difference* of potential; in hydraulics, it is the *difference* of head; in air masses, the flow is the result of *difference* in barometric pressure, etc. By analogy, therefore, if for no stronger reason, the flow of vapor away from the water surface is better measured by a *difference* of vapor pressures, rather than by a ratio.⁴

There is no part of the Bigelow equation (9), as thus far developed, that enables the expression to take on a zero or negative value as it must do to represent natural evaporation.

At 0° C. $\frac{de}{ds} = 0.33$ mm. per degree. The value rapidly increases at high temperatures, and is 1.80 mm. at 30° C. This ratio can only become zero at very low temperatures when

water vapor no longer exists. The other ratio $\frac{e_s}{e_d}$ must also

have a finite positive value. It may sometimes, but not commonly, be less than unity, and it will rarely have a value greater than 4 or 5. Neither of these ratios can have zero or negative values. The power of the equation to represent either zero or negative evaporation resides as yet unrevealed in the C -term.

If we apply the expression—

$$(12) \quad E = C \frac{e_s}{e_d} \frac{de}{ds}$$

to a large body of water, like a lake or reservoir, where the temperature of the water is very nearly a constant from hour to hour and day to day, then the expression $e_s \frac{de}{ds}$ becomes sensibly a constant, and the only term left to provide for variations in evaporation is the ratio $\frac{C}{e_d}$ and the wind.

These broad generalizations indicate, we believe, that the use of such ratios as herein considered in evaporation equations is not likely to be productive of useful results.

Passing from this consideration of evaporation equations in general, we wish to comment briefly concerning the perplexities encountered in the discussion of the Reno and Indio observations, as already outlined in the MONTHLY WEATHER REVIEW.

The discordances are, so far as the writer can see, fundamental and unequivocal. Unfortunately, the original observations are not conveniently available, and the printed material has been built up very extensively by processes of both extrapolation and interpolation. In fact, a large part of it must be regarded as hypothetical, which, it seems, may explain some, if not all, of the trouble.

The chief discordance occurs in the observed amounts of evaporation in large pans floating in the reservoir, and in similar pans more freely exposed 10 feet above ground. The floating pans show very decidedly less evaporation than the exposed pans under what seem to be sensibly the same meteorological conditions.

There are only two possible explanations for this: either (1) some physical element influencing evaporation has not been duly recognized, and therefore not observed or recorded, or (2) the observations are subject to some systematic errors.

There seems to have been no omission whatever to observe regularly at Reno all the meteorological elements that we imagine influence evaporation in any way. We are, therefore, compelled to adopt the view that the actual conditions must differ in some systematic way from those shown by the obser-

³ Monthly Weather Review. January, 1909, 37: 3.

⁴ In this connection see below p. 70. Bibliography of evaporation; 1873, Marié-Davy — title.—C. A. jr.

vations. The writer believes that a part of the trouble, at least, rests in the estimate of the wind force itself and its effects. The pans exposed in the free air are relatively much more freely exposed, even in light winds, than the pans floating low in a great sheet of water, especially when we bear in mind that the floating pans are extensively surrounded by a floating raft and breakwater system designed with the specific object of checking wind and wave influences. It seems likely, therefore, that the vapor sheet over the floating pans must really have been less disturbed by the wind, and had a greater density than in the case of the pans more freely exposed.

It is hardly worth while to speculate on the details of this problem, or of the several factors of the equation, until we get a sufficient number of exact observations giving us the unequivocal facts upon which we can build. The further evaluation of the terms of the equation herein proposed must, therefore, be deferred to a later paper. It seems necessary, however, to point out at this time, by way of conclusion, that a certain attention is necessary in selecting the proper values of c_a and c_d to use in forming the potential term.

Our judgment on this point must be guided by a careful consideration of the actual mechanics of evaporation which we must consider just briefly at this time.

Evaporation by pure diffusion takes place only in perfectly quiescent air, and we know the process is a very slow one. It is the kind of evaporation that takes place from a pan of water in a large closed room with no appreciable ventilation or convection. An evaporation equation, such as herein proposed, and that seems to meet open-air, windy conditions, must, in all probability, undergo important transformations to fit it to conditions of evaporation by pure diffusion. On the other hand, a pure diffusion equation is likely to be quite unsatisfactory, if applied to evaporation in the moving open air. Conditions favorable to pure diffusion probably never obtain in nature, or so rarely, and for such a short duration, that the amount of evaporation is inconsequential. We must observe, nevertheless, that in very sheltered locations, subject to very little wind, the evaporation may be controlled by the laws of pure diffusion to a very considerable extent, and these must, therefore, come in for a full share of recognition.

Nearly all ordinary evaporation in nature, however, is so dominated by the action of the wind, even when gentle, and by convection generally, that the mechanics of the phenomenon are very complex and very different from one of pure diffusion. Close down to the free water surface we must have a thin layer of air that is heavily charged with water vapor. The Reno observations of humidity one-half inch above the water surface show only a little more vapor than is in the air two or three feet higher. This indicates that the dense vapor sheet is very thin. We know, however, from our knowledge of viscosity and the flow of fluids that in spite of ordinary moderate wind action the thin gaseous sheet immediately next to the water is changed and renewed by the wind only with relative slowness. Vapor molecules that once pass beyond this thin, slow-changing sheet get caught up into the general circulation of the air we call the wind, and are carried away indefinitely.

In the absence of definite data to work upon it would seem that the potential term should be made up from measurement near to, rather than at some distance from the evaporating water surface. As already stated, however, the further solution of these important details must be deferred until some new data are available.

CHANGES IN THE MONTHLY WEATHER REVIEW.

In order that the readers of the MONTHLY WEATHER REVIEW may be prepared for the approaching changes in the scope and character of the Review we print the following order recently issued by the Chief of Bureau.

It appears from the following that those readers particularly interested in climatological statistics should request that the Review be continued to their address; those who are more interested in theoretical and technical discussions of data should request that the Mount Weather Bulletin be sent them in the place of the Review.

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU,
Washington, D. C., March 12, 1909.

Hereafter there will be combined in the MONTHLY WEATHER REVIEW all of the State Monthly Climatological Reports, except those from Porto Rico and Hawaii, which with Iowa, will continue as separate publications, but Iowa will also furnish to the Review the same data called for from other sections and it will be included in the Review. The Review will hereafter be a monthly report of the weather and climatology of the country, and there will be excluded from its pages everything technical that is not of a purely climatological nature or a current report of weather conditions.

It will contain no mathematical discussion or formulas. Such mathematical or other technical papers as receive the approval of the Chief of Bureau may be printed in the Mount Weather Bulletin.

The title page will not be changed. The cover will be the same color, but will be of the same weight of paper as that used in the Mount Weather Bulletin. The character of the material to be contained in the Review is generally indicated by exhibit "B," of which everything having a blue pencil mark will be eliminated.¹

The Review will be printed under the direction of the Chief of Bureau, as indicated on the present title page. No other credit will be given on this page. Each article will be signed by its author, whose name may appear either at the beginning or at the end of the matter, and the Editor's and Assistant Editor's names may be printed on the second page as now.

The issue of the Review will be limited to 5,000. Each section director will be allowed enough copies to supply one copy to each cooperative observer and a few additional copies for distribution only to such as may make a profitable use of the publication. In this connection it must be carefully impressed upon section directors and others that this publication is an expensive one and its distribution must be rigidly limited. When the section directors and libraries and colleges are supplied, the remaining copies will be sent to such of the names on the present mailing list of the Weather Review as may be selected by the board composed of Mr. Williams, and Professors Abbe and Bigelow. Each section director should receive from 10 to 20 extra copies, depending upon the interests in his State to be served by such a report; the number will be determined by the Chief of the Climatological Division.

The report from each section will include the general table and daily precipitation, but the daily maximum and minimum table will be omitted. The Editor of the Review will prepare two charts, at least of the size of the daily weather map; on these charts he will enter such data from cooperative stations as is necessary in the publishing of a monthly temperature chart and a monthly precipitation chart, the temperature chart to include the arrows showing the prevailing direction of the wind. Special care will be exercised in the drawing of these charts so as to recognize the influence due to topography. Where no data is available, the charts will be drawn in accordance with the effect that mountains are known to have upon precipitation and temperature.

The Editors will prepare a complete discussion of the clima-

¹ These blue pencil marks, as put on the Monthly Weather Review for October, 1908, cut out the district reports on p. 326-7; everything on p. 327-345, except "Rivers and Floods," and "Weather of the Month," the table on p. 356; also Chart IX.